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Developing a framework of artificial intelligence for fashion forecasting and validating with a case study

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Abstract: Artificial intelligence has become an emerging topic of great importance in fashion business recently; however, a systematic and comprehensive review of literature was yet to be carried out. We review the previous studies in the context of artificial intelligence and related technology usage by fashion companies and explore this new paradigm shift in the fashion industry. We created a framework of AI-based product forecasting in fashion and validated this framework with a case study in this paper. From online databases, books, magazines, blogs, industry reports, podcasts and even YouTube videos, relevant articles, extracts, chapters and multimedia contents were retrieved, and were systematically analysed to develop a framework. We found extensive usage of AI and machine learning in fashion industry and documented this. The framework developed by us can be applied to create products, improve margins, minimise inventory, and enhance business results in the fashion industry.

Keywords: artificial intelligence; fashion forecasting; computer vision; machine learning; AI framework.

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1 Introduction

"Clothes make the man", said Mark Twain once, but what makes the cloth is a question that the fashion industry is trying to answer these days using artificial intelligence, deep learning, machine learning, internet of things, and human-robot interface (HRI). Artificial intelligence can process humungous volumes of data and create business insights, which saves time, reduces errors, minimises cost, and aid current business practices (Mohapatra et al., 2018; Mohapatra, 2019). Predicting human behaviour has become much easier currently with the help of deep data driven technologies and self-learning machines. Visual images are processed, coded, categorised, analysed those aid business decisions in real-time. The fashion industry has not been untouched by this. This paper tries to document a few existing works in the fashion industry and develop a holistic framework that may help to tap new and upcoming fashion trends more quickly and accurately.

Through a systematic and comprehensive review of literature 363 articles as well as multimedia contents were evaluated carefully to identify theoretical constructs which were underpinned as a conceptual framework in the second stage. After creating this framework, we have validated this framework using a case study of a 'fashion intelligence company' based in Bengaluru, India. This company claims to be the first company in the world to use artificial intelligence and specifically machine vision to forecast fashion. This case study has been prepared using secondary data available over the internet in the form of articles, interviews, press releases, and social media posts.

2 Literature review

Sproles (1979) opined that a fashion system has two main ingredients, a fashion object, and a fashion process. A fashion object is a particular product, style, colour, silhouette, an innovative technical feature, or a new membership service. While a fashion process is the process through which it emerges from its creation and travels to public presentation, trendsetters, early adopters, acceptance/rejection by the majority, replacement with a newer object, and merge of next trend. We assume that AI has capabilities for both, i.e., it can predict the fashion object by analysing the fashion process. The history of AI techniques dates back to the 1930s, however, with advances in computational speed, data storage, data collection and handling, data retrieval processes have become faster and reliable, AI is covering a broad spectrum of industries now (Mohapatra, 2017). Artificial intelligence-based machines are known for their consistency, speed, accuracy, cost-effectiveness, and have improved performances and productivity (Boden, 1990; Ferreira et al., 2007; Zhang and Richardson, 2007; Wang and Rasheed, 2014; Darko and Chan, 2016).

Fashion has become a $3 trillion industry today (Fashionunited.com, 2019) with more than 150 billion units of garments manufactured in 2018 alone (Apurba, 2019), however best of the fashion retailers make 10%–11% operating profits or earnings before interest, tax, and amortisation (EBITA) (Subramanian, 2014). Half of what is manufactured is either sold on discounts or never sold, creating huge carbon footprints (Apurba, 2019). According to the McKinsey Global Fashion Index (2019), the top 20% of companies in fashion commanded an average profit of 128%, the next 60% made 6% profits, whereas the last 20% companies made –34% (negative) profits in the year 2017, in a random survey of 500 companies. The same report tells, only the top 20 companies in their list contributed to 97% of profits in the year 2017, making fashion business highly skewed towards super performers, when it comes to profitability. A recent article in Forbes (Schmelzer, 2019), reports that using a technology like AI can reduce the forecasting error by up to 50% in the fashion industry. Subramanian (2014) outlined that by reducing forecasting error by 5%, profitability can jump by 25%–30%. Standish and Ganapathy (2018) emphasised on the same but added that AI may bring inventory levels down by 20%–50%.

Today, AI systems are being employed in a variety of ways by the fashion industry such as designing clothes through intelligent forecasting, providing intelligent sales assistance to assist consumers in making quick and right choices, optimising manufacturing, hyper-personalising marketing through micro targeting, and enhancing fashion sales processing as well as consumer experience through intelligent fashion guided systems such as chatbots. AI assisted e-commerce apps enable customers to click

a photo or take a screenshot of a fashion product which they like from physical or virtual environment and search for matching items in that category. Even giant companies such as Microsoft, Apple and Google are helping to improve fashion shopping experience using voice assistance devices and conversational interfaces such as 'alexa', 'cortana', 'google home', 'siri', and 'baidu'. These interfaces provide 24*7 engagement and assistance (Cognilytica, 2019; Schmelzer, 2019). AI spending in fashion and retail industry which is currently valued at nearly $2 billion per year in 2018–2019 to quadruple and become nearly $8 billion by 2022 (Alvin, 2019; Juniperresearch.com, 2019).

We witnessed many works where the fashion industry has leveraged these upcoming technologies but focused only on how AI can assist in better forecasting for fulfilling the objectives of this paper. In the next sections, we have briefly discussed how the fashion industry is changing with time and technology.

2.1 Fashion forecasting: conventional approach

Fashion forecasting has been compared to chasing the future with a butterfly net (Gardener, 1995). Forecasters are people who pluck emerging and prevailing trends out of public information (Popcorn, 1991). They vary in methods they use but look for an apparatus that can help them predict the mood, behaviour, and buying habits of the consumers. Season after season, product developers, merchandisers, and product managers look for short-term trend forecasts of colours, textiles, silhouettes, and overall style directions. Forecasting comprises of tools and techniques that can be applied systematically, but among all 'scanning' plays a significant role. Forecasters look at historical sales data, communication with supply chain partners, competitive scan, environmental scan, consumer scan, and fashion scan, which eventually translates into colour, fabric, style, silhouette, and overall look for the upcoming season (Keiser and Garner, 2008). The traditional methods of gathering forecast data included trawling art exhibitions, restaurants, concerts, events, and even scientific journals. Fashion forecasters often photograph trendy people and celebrities, travel to fashion cities, follow catwalk shows, and spot vintage as well as upcoming trends. Fashion auxiliary services offered by the media like fashion magazines, general consumer publications, information resources like fashion consultants, and information services are essential ingredients for new product development and long-term forecasting (Stone, 2001). These works reveal that the traditional nature of fashion forecasting was based on observations, scanning of the environment, expert judgments, and human intuitions.

2.2 Fashion forecasting: contemporary approach

A few works in existing literature also reveal that researchers have tried to address this field with some analytical models. Garro (2011) addressed the problem of sales forecasting with fast-fashion retailer Zara by developing regression models based on past sales data and unsold inventory. Ferreira et al. (2016) used a similar model but drew regression trees. Huang and Liu (2017) used 'adaptive neuro-fuzzy inference system' (ANFIS), which outperformed the traditional artificial neural networks (ANNs) in forecasting demand for fashion products. Some more studies report the usage of past sales data for forecasting the demand for fashion, Tehrani and Ahrens (2018) using classification algorithm, Choi et al. (2014) extreme learning machine (ELM) and grey

model, Ren et al. (2014) panel data model, etc. a variety of other predictive models as well as deep learning approaches such as decision trees, random forest, support vector regression, ANN, ELM and linear regression (Loureiro et al., 2018; Sun et al., 2008; Xia et al., 2012). However, the past sales data-based complex models have certain limitations. First, they neglect the qualitative aspects such as the role of expert judgments, creative, artistic, and emotional aspects of the fashion product; second, there is a dearth of long sales histories for fashion products as the product itself has a short lifecycle (Goodwin, 2017). In his article titled 'Forecasting after a fashion', he heavily criticised post fashion post-mortem-based methods of forecasting. Another set of researchers addressed this problem of forecasting using expert opinion as well as survey-based methods. Noh and Ulrich (2013) used the Delphi method to survey fashion professionals and find out long-range trends; an empirical work by Saha and Roy (2012) matches designers' opinions with consumers' opinions through interviews and surveys using conjoint analysis to design an office shirt. These sets of methods are subjected to a series of limitations such as unavailability of data every season, low cost-effectiveness, and time-consuming. Previous literature also have instances of usage of some popular AI techniques in building fashion forecasting models like fuzzy logic (Eberhart and Shi, 2007), neural networks (Eberhart and Shi, 2007; Cheng and Liu, 2008; Banica et al., 2014), genetic algorithm (Tokumaru et al., 2003; Kim and Cho, 2000), Bayesian networks (Russell and Norvig, 2009; Yelland and Dong, 2014), decision trees (Kokol et al., 2006) and knowledge-based systems and their variations (Eberhart and Shi, 2007). Despite all efforts, forecasting remains the number one challenge in the fashion business (Subramanian, 2014). Gaimster (2012) argues that the nature of fashion forecasting industry is changing dramatically in recent years. Several factors contribute to this change, but the key driver is the impact of technology. Brannon (2010) emphasises in her book that the internet is proving a boon to fashion forecasters in the form of cost savings, ease of reach to the target audience, and providing information near to selling season. Hence, we tried to find a few more works where technology acts as an enabler for fashion forecasting.

2.3 Fashion forecasting in machine vision era: the future

The rise of computer vision in recent years has changed the landscape of the fashion forecasting industry (Wong, 2012; Zou et al., 2018). E-commerce and social media are the main leverages of the fashion industry in recent times. Social networking sites such as Facebook and Instagram are generating tons of data, both structured as well as unstructured, that may be analysed using AI-based algorithms for better operational decisions such as designing or merchandise planning of certain products before they reach the peak of their popularity (Franco, 2018). According to Scoltz (2017), this data has characteristics like volume, variety, velocity, veracity, variability, complexity, and viability, which makes it humanly impossible to process and make decisions without a machine interface. Machine vision became firstly popular in the area of radiology with its applications in medical diagnosis. With advances, it got introduced to the field of fashion with image processing features and its ability to classify images based on colours, textures, shapes, and sizes (King and Lau, 1996). Processing images to get business insights has become popular in the present era of artificial intelligence driven technologies. Many industries are processing visual images to create tasks which aid their current practices (Sarkar et al., 2017). Many big corporations like Google, Microsoft and

IBM are providing image processing-based solutions to fashion industry. In April 2018, software giant Microsoft, published an article in their developer blog webpage, where they introduced two of their recent applications developed jointly with an international fashion retailer. The first application, named 'Grabcut,' enables users to extract photographs of fashion products from typical day-to-day photographs of users. It uses a Gaussian mixture model having five components and use an iterative optimisation algorithm that removes the background unwanted noise from the pictures. The second application, 'Tiramisu,' is an image segmentation architecture that uses a deep-learning-based algorithm and binary coding of foreground and background pixels for classification, factorisation, and segmentation. Microsoft claims that this model achieved 94% accuracy during training mode, making it fit for further use (Microsoft Developer Blog, 2018).

Computer enabled image processing, by and large, has become a hot topic in both practitioners as well as academic literature; however, a more systematic as well as holistic investigation of the entire fashion system may lead to a conceptual model which we have addressed in the present work.

2.4 Social media and e-commerce: the future of fashion intelligence

Social media and e-commerce in recent years have created a goldmine of data for researchers and practitioners. Pictures, texts, hashtags, likes, shares, and comments, carry pieces of information on users' behaviours at any given time. Many fashion brands are analysing conversations of its consumers on Web 2.0 space to understand user sentiments and the direction of fashion. Some fashion houses and trend forecasting companies are putting their latest collections on social media sites like Instagram and measure public engagement (Jain, 2019). Picture sharing sites such as Pinterest, Tumblr, and Instagram are helping to keep brands' consumers up to date about the latest styling information making the flow of fashion information faster. Also, people are following their fashion icons more quickly, which makes fashion more democratised (Davis, 2018). Zhao and Min (2019) published a study in which they investigated consumer's interest in haute couture during Paris fashion week, with the help of hashtags. Having the right social media strategy is linked with the turnaround of many brands. Most successful of them is British fashion luxury brand Burberry (Phan et al., 2011), which was spending a whopping 60% of its marketing budget on social media as early as 2014. This helped Burberry to tap consumer emotions, strengthen the relationships, and use it in the new product development process (Straker and Wrigley, 2016). Despite these, a study finds that less than 50% of companies use social media in the new product development process. Strangely, most of the companies which use social media in the new product development process are the ones that have 'innovation culture' in them and are ready to invest in unconventional sources such as AI (Roberts and Piller, 2016). The focus of most e-commerce companies in present times is on presenting the most appropriate selection to the consumers through personalisation and curation and not on the most extensive selection; AI makes it possible (McKinsey Global Fashion Index, 2019). In the last few years, there has been a rise of few fashion intelligence companies which are using data to support intuitions and strengthen decisions on fashion products. MakerSights, a California-based AI firm, combine factors such as social media activity, e-commerce sell-throughs, search queries, and consumer feedback to provide clues into what is most likely to become a trend (McDowell, 2019). Fashion retailer Debenhams uses an

analytics platform EDITED (edited.com) to spot trends using computer vision, machine learning, and natural language processing (NLP) (for texts) along with other AI techniques to spot the next fashion super-style. According to a report published in the Fortune magazine, Edited uses 8 billion data points, 15 million photographs, 1,000 retailers around the globe and tracks 80,000 fashion influencers on social media to provide smart insights on 'what will sell' to its clients (Noyes, 2014). A similar service named analysis+ is being offered by a leading fashion forecasting company WGSN. Stitch-fix, an online styling service in the USA, uses machine learning algorithms to design trends, give customers a personalised experience, collect feedbacks and come up with a monthly guide to shopping (Cognilytica, 2019; Algorithms-tour.stitchfix.com, 2019). Another company, MakerSights, is using data-analytics that combines multiple factors such as search queries, consumers' activities on social media, e-commerce sell-throughs of competing products and consumer feedbacks to provide clues into what is most likely to become a trend (Alvin, 2019). There is a long list of similar fashion intelligence services such as Jwtintelligence, Nextatlas, Google trends, Baidu, Heuritech, Fashionunited, Spate, and Stylumia are to name a few (McDowell, 2019). Not only big fashion houses but also small designers are using AI services such as IBM's cognitive clothing to create right products, today. Shane and Falguni Peacock, two Indian Bollywood designers analyse 600,000 images of couture to forecast the next upcoming colour or trend using IBM's cognitive clothing (IBM India, 2019).

3 Gaps in literature

The existing literature on using artificial intelligence in the fashion industry to forecast products is at a very nascent stage. We found a good number of articles on how researchers are using various AI techniques to solve specific problems. We also came across certain industry applications and brands using AI to strengthen business decisions; however, we did not spot any framework of AI usage designed explicitly for the fashion industry. Moreover, most of the recent works related to industry applications were found in various webpages, podcasts, interviews, and magazines. Hence, there is clear gap observed in academic literature even with respect to applications of AI for fashion forecasting and predictions. Mohapatra (2019) has outlined the importance of having industry-specific frameworks of AI for full-bore applications as well as for future research. There are not enough works in AI and its applications in the fashion industry in the context of developing economies. Hence, we have created this framework and also validated it through a small case study of a company based in Bangalore, India.

3.1 Research objectives

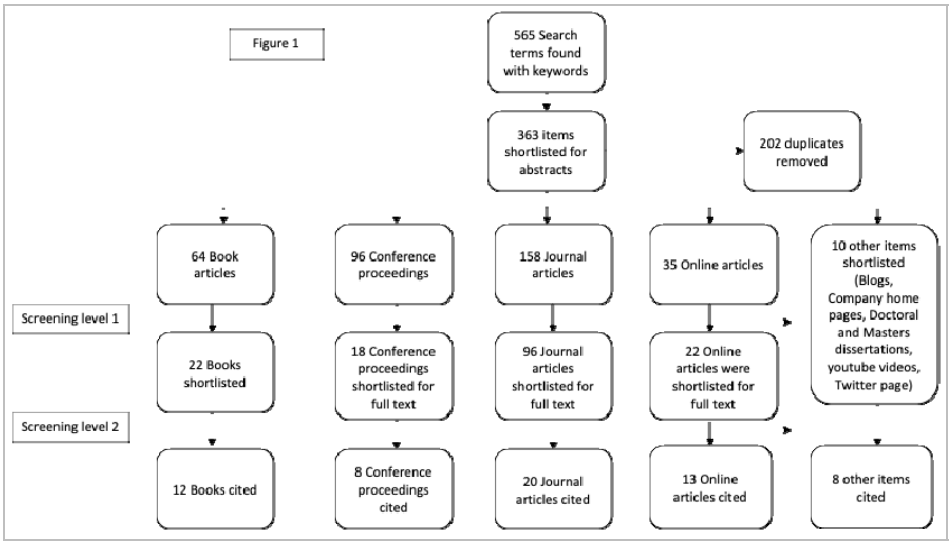
From the discussion, it is evident that there needs to be a firm theoretical base for applying AI in the fashion industry. This will make it robust and sustainable. At the same time, it will create an opportunity for future research for testing, applying, and adapting the framework for problem-specific applications. There are not enough case studies in the fashion sector, which hinders the understanding of where AI can be used and where it cannot be. Therefore, we have developed this framework for the fashion industry. Primarily, there are two objectives of this paper, first, to review the existing literature of artificial intelligence and its applications in the fashion industry, second to develop a

framework of artificial intelligence suited explicitly for the fashion industry. Secondarily, we have also attempted to validate this framework with a case study.

3.2 Methodology

For the purpose of literature review, we looked for related articles from peer-reviewed journals, books, websites, online publications, magazines, fashion blogs, conference proceedings, and industry reports to critically review the existing literature on the fashion industry and artificial intelligence. The field of inquiry in context, being considerably new in the academic literature, we chose to review it from different angles, perspectives, and sources. We searched five major databases namely, Ebsco (Business source complete), ProQuest (ABS complete), JSTOR, Google Scholar, and Emerald, between October and December 2019. Titles and abstracts were screened and selected for full text analysis only if they have been written in English and contained information related to both fashion Industry and artificial intelligence applications. To locate online resources, we have utilised Google search. We performed key word search with words like 'fashion forecasting', 'artificial intelligence', 'AI', 'fashion intelligence', 'AI techniques', 'machine learning', 'deep learning', 'AI framework', 'AI application in fashion industry', 'computer vision', 'machine vision', etc. From the filtered articles, meaningful extracts were done and used for writing this paper. Figure 1 shows the flowchart for study identification.

Figure 1 Flowchart for identification, screening and shortlisting of studies



Of the 363 articles identified by our search, 168 met our inclusion criteria, 195 were irrelevant to the topic of the review and were screened at level 1. At screening level 2, only those articles were chosen, where artificial intelligence tools were applied on fashion problems and specifically product forecasting area. Thus, we cited those 61 items. These items included e-Books, conference proceedings of reputed conferences such as IEEE, journal articles, online articles of prestigious magazines such as Forbes, Economic times, Vogue, Fortune, WWD, and The Economist. Apart from this, we also

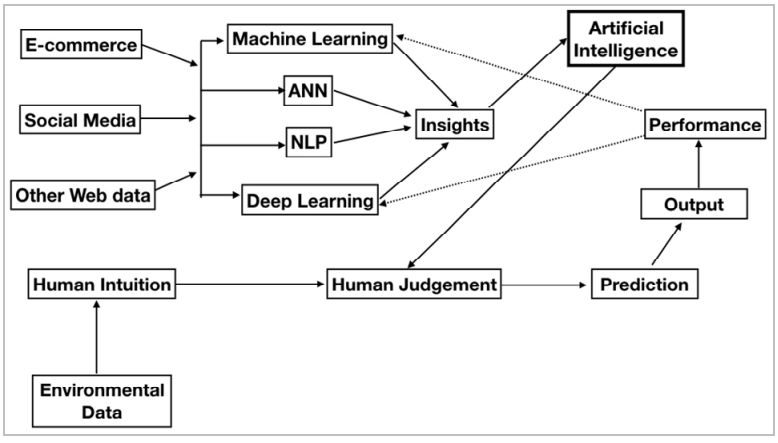
included one podcast, one MIT Doctoral Thesis, few company homepages, and other resources such as YouTube and twitter accounts of reputed companies like IBM. We have also referred few books to understand the dynamics of fashion forecasting and artificial intelligence. The extracted information included the name of the authors along with their affiliations, criteria for sample selection, specific details on variables that affected AI applications, publication year, and DOI; we also noted names of the journals that had published these articles. In addition to these, we also retrieved the countries or geographies where these researches were carried out. References were created using in-built referencing tools in the databases or third-party websites such as 'citethisforme' and 'citationmachine'. For preparing the case study to validate our framework, we have riffled through various online articles, blogs, twitter pages, the home page of the company, and youtube videos of its founders.

3.3 Proposed framework

Based on a systematic review of the literature, we derived our theoretically validated constructs from which we have developed a conceptual framework. From the literature, we uncovered that there are majorly three sources of input data related to fashion product in an AI system. These are e-commerce, social media and other web data which is highly scattered across texts and images over billions of data points. This data is both structured as well as unstructured. The recent advances in AI come with machine learning tools, which include programming machines and computers to produce useful data insights (Beetz et al., 2010). Visual intelligence and computer-based image processing algorithms based on deep learning architecture can track, recognise and process images derived from e-commerce websites and apps for a particular product at a given point of time in a defined geographical region with the help of deep learning tools. Brands can also track consumers who follow their brand pages and generate texts as well as images data about consumers' publicly shared pieces of information (which is free from any privacy issues). This information can quickly reveal what consumers are buying and wearing at present. Existing literature tells that basically four types of AI techniques are popular in the industry. These are machine learning, deep learning which brings precision in image processing, NLP popular with chatbots and speech to text converters, and ANNs which majorly helps in preparing human like recommendations. On the other side, human intelligence can be used with traditional tools of fashion forecasting such as expert judgment, forecasters' intuition, observations, and following trendy people. We have put them under a construct and named it environmental scan. This is another input data source. In fashion products, certain elements such as design, aesthetics, emotions, sentiments, comfort, look, feel, fit, and finish, play a significant role, hence human judgment has been given more eminence in our model. In our framework, technology acts as an enabler, AI aids human judgement to predict the near to right products. However, products' performances are evaluated at the point of sale (POS), and data related to their sales and markdowns (discounts) are fed back into the system (dotted line). This data is both in texts, characters and images. Using deep-learning and machine-learning tools, this data produces insights that are again used by the artificial intelligence system to strengthen decisions next time. Over a while, the AI system accumulates enough data to replicate human judgments. This is also the stage where deep learning algorithms begin to work as deep learning requires more data than machine

learning to train the model and provide more accuracy in outcomes. Our conceptual framework is given in Figure 2.

Figure 2 Artificial intelligence framework of fashion forecasting



To validate our framework, we have documented a case study of an AI firm which uses machine learning and computer vision on e-commerce and social media data to predict 'what will sell' for its clients. This company is based in India and currently serving a clientele which is based in both developed and developing economies. Within a short span of four years, this company has created an international niche market for AI application in fashion and lifestyle industry creating multiple success stories and solving real life problems of fashion industry through visual intelligence.

4 Case study: Stylumia (AI in fashion)

Stylumia is a fashion intelligence company based in Bangalore, India. It is founded by Subramanian and Ramprakash in 2015. Ganesh, who is in his '40s now, has earlier worked with companies like Walmart and Myntra (an Indian e-commerce giant). In his last stint with Myntra as CMO, COO, and head of new initiatives, he built a private brand for Myntra (named Roadster), which was purely an AI-driven brand that performed better than all human intelligence-driven brands of the e-commerce giant. Ganesh claims this was the world's first artificial intelligence-driven fashion brand, which was scaled up to USD 20 million in a matter of 12–14 months. Having the pain of fashion business for prolonged and working in a technology company, he already knew that the biggest problem of the fashion industry is products not selling full prices because consumers do not like them. In fashion business consumer side is very dynamic, whereas the supplier side is very rigid because of long lead times, forecast errors, short lifecycle products (usually in weeks), and extended supply chains. But most importantly, the information gap i.e., product decisions are solely taken on intuitions, which have higher failure rates than success rates. This was not just the problem of one retailer or a few; instead, the entire industry is a victim of inaccurate forecasts. This was the genesis of Stylumia (which means illuminating the business of styles with technology). He, along with Ramprakash (an AI scientist and an artist), laid the foundation of Stylumia, which is a

machine learning and AI platform for other fashion retailers. The company believes, listening to the customer is the key to success for any business, but listening at this scale requires technology interventions. Stylumia believes in nowcast (than traditional forecasts) where it uses data from e-commerce platforms across the globe and social media sites such as Pinterest and Instagram to produce insights on products, attributes, brands, and prices for its clients that too in real-time. Some of their clients registered a 200%–400% jump in revenues (transformational not incremental) and 200%–300% jump in social media engagements when they posted these newly AI developed styles on social media. The company believes that any relevant knowledge used in decision making will make decisions always better, especially when computer vision and machine learning is empowering expert human judgments; the results are astonishing. Computer vision can see an artistic product like fashion in the same way a human eye sees it or at times better than it. When pixel-level intelligence is processed on machine learning-based algorithms, the insights produced, have remarkable accuracy. The company has two kinds of solutions Market Intelligence Technology (MIT) and Fashion Intelligence Technology (FIT). The data source for MIT is internet data, which produces insights on what is selling globally. They offer filters on their user interface, which enables the user to select particular geography or a brand or a specific price-point, whereas FIT is about a brand's performance-related data (product intelligence) which includes, items, SKU's, stores, and performances. The algorithm enables the machine to train with time on a self-learning mode and season after season its accuracy in prediction increases driving higher customer retention for Stylumia. In 2019, with a team size of just 18 people, Stylumia marked its presence in five countries and is expected to cross $1 million in revenues with a Y-O-Y growth of 3–4 times. Their clientele includes many coveted names in the fashion industry, such as Puma, Wrangler, Pepe Jeans, Jack & Jones, Aeropostale, Myntra, Wrogn, Fastrack, W, Biba, Global Desi, Breakbounce, Vanca, Wet Blue, Deezeno and Femella are to name a few.

This case is prepared with the help of online articles, mainly The Economist (2017), Economic Times (2017), Sharma (2016), Apurba (2019) Goswami (2019) and Chengappa (2018) along with a few youtube videos of Stylumia and its founder Ganesh Subramanian. We have also browsed its homepage (stylumia.com, n.d.) and twitter page (Stylumia@twitter, 2019).

5 Managerial implications and discussions

We are writing this article at a time when the marriage of AI with fashion is still in infancy. AI is a continuously evolving domain with widespread industrial applications. Till now, it was capable of penetrating industries with repetitive tasks only, but in the future, it will venture into industries that were always considered to be unbeatable by machine intelligence. One such industry is the fashion industry, which was always thought to be driven by human design and artistic intelligence. However, unlike some other industries, the role of AI here will be as a tool to validate human judgments. Some designers feel that using AI to design fashion products will create dull designs (The Economist, 2017). However, in our framework, we have used AI as a tool to facilitate human decisions and not to stifle creativity. AI suggests what attributes and price points might sell; however, the judgmental calls have to be taken by humans. In our conceptual model, we have highlighted the role of humans and machines in jointly

developing a consumer loved product. One significant contribution of our model is that the AI system also learns from human judgment with time. The case study we have discussed fits our conceptual model. In the case study, where MIT has a data input source from various internet platforms, FIT trains the model with its own data itself. This is as per our model where the machine learns from the output of combined human judgement and AI predictions.

As the basis for any computer program is an algorithm and the basis for any algorithm is a conceptual framework, hence our paper may have managerial significance as the conceptual model we have developed may be used to design AI-based solutions for fashion industry.

6 Future scope

At present most of the researches in AI are about inventions; however, in the future, the main challenge will be in applications. It will be interesting to see how modern-day employees accept these innovative technologies. It may require humans to disengage in certain activities and involve in creative and judgmental roles, which will include supervision, problem-solving, ethics, responsibility, and leadership. Some researchers (Standish and Ganpathy, 2018) argue that including a technology like AI may cut down designers' jobs by 30%, however, it may open new avenues by adding value to the overall design process. Fashion designers will be able to take accurate and precise product decisions that may further boost their creativity as they may be able to focus on the creative aspects more in the light of data. AI for fashion product development has already become popular in industry however more refinement may lead to higher accuracy and efficiency. In the future, having AI will be a necessity for businesses than a choice, and a large pool of industries, as well as consumers, will benefit from it. Our model may be used for future research in this area. Also, there could be different forms and adaptations of the model suited for different types of retailers such as value, premium, and luxury, as well as different scenarios. Our model may be a base for deriving the future models. Any conceptual model has to bear the test of time before it is universally acceptable and applicable, so as ours. In future, there could be different forms and adaptations of our model to be created by future researchers.

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